SOME CHARACTERS IN THE PERLIDÆ*

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Many years ago when I started to classify our Perlidæ I neglected to study the head, antennæ, and legs. In recent years others have emphasized the importance of genitalia and nymphal structure. Species are physiological units, genera are structural units. Reproduction is one of the most important physiological processes, so that the structure of the genital parts is of great value in species. These vary from species to species so that only in a general way can they be used for genera. If the genus is to be something different from the species, it must rest on characters which are not commonly used for species. Species reflect adaptation to environment, the recent and temporary life. Genera should rest on long-inherited structures, of little or no use to the adult, but which reflect heredity; characters common to several species.

The wings of *Pteronarcys* and *Isoperla* have many differences, but for each genus the wing is efficient; the great number of crossveins in the former genus is not necessary, they represent inheritance, not use, and so become of value in the classification of genera or higher groups.

Of the several structures that I have observed, the anal lobe of the fore wings[1] and a vein (anal brace), arising from the under side of the anal cell, and crossing the anal lobe seem to me to represent the course of specialization. In *Pteronarcys* the anal lobe is very large and the anal brace (vein that crosses it) complete and strong. In

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[1] This anal lobe is rarely shown in figures of wings. Figure I in Needham and Claassen shows the anal area of fore wing but does not indicate the line of fold which separates the anal lobe from the rest of the wing. Many figures indicate the anal brace but often only partially or incorrectly. In the Selys part one, Klapalek on page 6 shows line of fold, in part 2, page 9, he shows the anal brace. N. & C. on plates 13 and 16 show the anal brace in *Perla* and *Acroneuria*.

Figures 1 to 8 I have indicated the gradual modification until it vanishes in *Peltoperla.* In *Pteronarcys* the anal brace extends obliquely backward (recurrent). Other general with an oblique recurrent anal brace are *Acroneuria, Togoperla, Banksiana, Neoperla, Perlesta, Pteronarcella, Harrisiola,*[2] *Perlinella.*

In *Isogenus* the anal brace arises closer to the base of the anal cell and extends transversely to the margin; other genera in this group are *Perlodes, Clioperla, Hydroperla.* Those in which the anal lobe is very small and folded under and the brace vestigial are *Isoperla, Paraperla, Diploperla,* some species placed in *Clioperla* (I am not sure of genotype). In *Atoperla* there is a very short basal part of anal brace arising before base of anal cell, often difficult to determine. In many cases the outer part of anal brace is weaker than basal part. In some species of *Isoperla* the lobe and brace are very small and weak or absent, in few distinct. In five genera the lobe and anal brace are absent: *Peltoperla, Alloperla, Chloroperla, Kathroperla,* and *Hastaperla.* In *Perlesta,* and sometimes other forms, the anal brace is bent at the line of fold.

ANTENNÆ.

The antennæ in Perlidæ are rarely mentioned except to note the color. Walker, in the descriptions of two species (*decolorata* and *decisa*) says antennæ "very minutely pubescent" and "brown, minutely pubescent."

The antennæ of *Pteronarcys* and *Acroneuria* have joints near the base very short and broad, some, at least immovable; in *Togoperla immarginata* it is similar. In *Perlodes* the joints near base are usually longer, but still broader than long; also in *Isogenus* and *Hydroperla.* In many of the species placed by Needham and Claassen in *Perla* and *Clioperla* the third joint is plainly longer than the fourth, the latter and several following joints being much broader than long. In this type of antennæ the joints are not narrowed at base until much further out

[2] *Harrisiola* (type *Perla flavescens* Walsh). I use this name for the species (except type) that were put by Klapalek in *Neophasganophora;* the type species being a *Perla.*

where the joints are much longer than broad. In *Pteronarcella* the joints become longer than broad much sooner. In all of these the hairs on the antennæ are very small and fine, well described as "minutely pubescent." Often they are erect, but in some slope toward tip of joint. In *Togoperla* the hairs, though longer, are closely appressed; in *Perlinella,* though short, are also appressed.

In the genotype of *Isoperla* (*bilineata*) the joints near base are as long as broad, the hairs are very short, but near the tip or beyond the middle is a longer erect hair, which I shall call a sense hair. In other species of *Isoperla* it is the same, but a few (*ebria*) that have sometimes been placed in *Isoperla* do not have these sense-hairs, or at least not well-developed. In *Alloperla,* in *Perlesta,* it is the same as *Isoperla.* In *Neoperla* the hairs are longer but the sense-hairs are very prominent, also *Diploperla, Paraperla,* and *Kathroperla,* as well as *Chloroperla* and *Hastaperla* have them more or less distinct.

In *Isogenus* and *Perlodes* there are no sense-hairs or else so small as to be unnoticed, in *Hydroperla* some species show very tiny erect hairs toward the tip of the joint, but in others they are very small or absent, in some *Diploperla* they are also short, but usually distinct and near tip of joint, in *Clioperla* (*similis, slossonæ*) they are readily seen. In some *Acroneuria* (*xanthenes, californica*) the sense-hairs are fairly distinct, beyond the short joints, in others they are obscure or absent. In the *Perlinæ* distinct, but not as prominent as in *Neoperla.*

Head.

In shape the head ranges from twice as broad as long (*Peltoperla*) to twice as long as broad (*Paraperla*); and behind the eyes the head may extend more than twice the diameter of the eye (*Kathroperla*) or there may be scarcely any space at all (some *Hydroperla*).

The head may be considered as of three areas: occipital area, the part behind eyes and ocelli; the interocular area, and the face or area in front of anterior ocellus. The occipital area is often very short in middle, where it is

separated from the interocular area by a curved line or groove, the occipital line, the ends of which curve forward. Just behind the eyes the head usually narrows toward the pronotum, but in a few forms (*Perlodes, Atoperla*) the side at first bulges outward before it starts to narrow. In the middle there is frequently a line or groove from the occipital line to the rear of head; this median groove is present in *Perlodes, Isogenus, Clioperla,* some *Isoperla,* also in *P. nona* and *obscura.* It is short or hidden in *Perla* (*Togoperla*), *Acroneuria, Harrisiola, Perlinella, Perlesta, Atoperla, Alloperla,* but is present in *P. luctuosa, P. modesta* and *P. phalerata.* It is present in some very small species as *P. ebria.* In *Hydroperla* it is not present, at least in sight, but sometimes a small groove on the hidden part of head or as a very fine line.

The occipital line is usually quite distinct in the primitive forms; in the more specialized it may show behind the hind ocelli, or be entirely obliterated. In *Perlodes* it slopes each side and ends in front of eyes; in *Perliphanes* it slopes less and runs into lower part of eye; in *Perla* and *Acroneuria* it slopes each side just outside of boss and is stopped by a ridge. In *Calliperla* it slopes each side a little concavely to a point near eye where it connects with a line sloping below inwardly, the outer part of the M-mark. In *Harrisiola* and *Atoperla* it makes a full semicircle, the ends running into the boss; in *P. modestus* it makes a broader curve, also ending in the boss each side, but not a full semicircle. In *Isogenus* it is lower and broad, stopping near boss. In *Perlinella* the sides disappear a little beyond boss. In *Perlesta* it connects top of ocelli, beyond vestigial. In *Isoperla* it sometimes shows sloping from behind the hind ocelli toward the eye, but more often it is not visible.

The interocular area has the three (or two) ocelli. They form a triangle as long or longer than broad in *Perla, Acroneuria, Harrisiola,* and some *Perlodes;* in *Isogenus, Pictetia,* many *Clioperla* and *Isoperla* the triangle is broader than long or at least as broad.

The hind ocelli are usually situated at about the middle of the eye-space; in *Perlinella* and *Kathroperla* a little

behind eyes, in *Alloperla* further back than usual, and sometimes behind the eyes. In *Isogenus, Hydroperla, Clioperla* and some related species the hind ocelli look more or less laterally from the head of a broad groove, there being a ridge on their inner edge as high as the ocelli; in *Isoperla* the hind ocelli look more upward; in *Acroneuria, Alloperla, Harrisiola* the hind ocelli project above the surface of the head. The distance of the hind ocelli from the eyes is, at most, only a character of species.

In nearly all Perlids there is a small swollen spot a little in front of each hind ocellus, and often further out. This is the lateral tubercle or boss. It is more or less characteristic in shape and position for each species. Sometimes hardly further than the diameter of the ocellus, again it may be five to ten times as far away. In a few cases it is circular, but usually longer than the ocellus, and one end may be enlarged, or narrowed at outer end. In front of the anterior ocellus is the face.

There is usually a transverse groove or a depressed spot in front of the anterior ocellus. In front of this there is on each side a smooth area, or raised area, usually elongate and sloping outward; frequently they are pyriform. These are the middle part of what Needham calls the M-mark; however it is better called the V-mark, since the outer sides are faint or absent in most species. Sometimes the two are joined together above in a broad curve. They never reach the front margin of head, and near each lateral corner may be a dark rounded spot. The shape and divergence of the V-mark are very good characters for species and species-groups. But sometimes widely separated genera may have the V-mark of very similar shape. I have figured a number of these, and I think they should be considered in descriptive work.

In some species the head is without marks, or only dark around the ocelli, but in many there is a pattern of dark marks, which has long been recognized of specific value. There is, of course, variation in the development of a pattern. When the same pattern occurs in two or more species, there are differences in structure; often in shape of the ocellar triangle or on the lower face.

The head of *Perlodes,* when viewed from above, shows the side behind each eye somewhat swollen before it begins to slope inward. Behind the eye of *Isogenus* the side is, at first straight, then slopes inward; in *Hydroperla* it is less distinct, since the head is shorter behind the eyes, but in *ebria* and *gravitans*(?) the side is plainly prominent before sloping. The last two species, when viewed from below, show a somewhat globose area behind the eye. In many species the side behind eye is convex, but it begins to slope at the eye. *Perlinella* and *Calliperla* show the side somewhat swollen before the slope.

Femora.

The femora have on their lower edge a row of short, fine hairs or the hairs may have above them a row of stouter bristles, or the hairs may be more numerous and spreading up on the lower part of the femur, and with bristles interspersed or in a row. Those with the row of short fine hairs are the genera *Perlodes* (and subgenera), *Isogenus, Hydroperla, Clioperla* and *Isoperla,* the other genera have bristles besides the hairs. In the *Perla* and *Chloroperla* sections there are always bristles on the femora, either in a row or among the hairs.

In shape the femora may be very long and slender, with nearly parallel sides, but in many of the genera with bristles among the hairs (*Perlesta, Neoperla,* Calliperlinæ) the femora are shorter, broader, and the upper edge convex.

Wings.

Needham and Claassen in the table to species of Perla use the position of the cubito-anal cross-vein to divide the genus in two sections, one in which this cross-vein is placed its length beyond the end of anal cell, and the other where the cross-vein is at end of cell or only a trifle beyond. In general it would be better to divide whether the cross-vein is at or before end of anal cell, or plainly beyond. The amount beyond varies a bit in some species. It is plainly beyond in *Isogenus, Hydroperla, Perlodes, Perlinella.* In *Pteronarcys* this vein is much beyond end of cell, so we may consider this a primitive character.

However in *Isoperla* both ways occur commonly, even sometimes in the same specimen.

One point in venation is very interesting, it is the forking of the cubital vein in fore wings; in all but two subfamilies the cubitus forks in such a way that the anterior branch diverges at least a little, but plainly, from the main stem while the lower branch either runs out nearly as a continuation of the stem or also diverges from the stem, so if stem were continued it would divide the fork. In two subfamilies, the Isoperlinæ and the Chloroperlinæ the upper branch runs out as a continuation of the stem and the lower branch definitely diverges from the stem. These two subfamilies, although having much general resemblance, differ so much in details of structure that this similarity in forking of cubitus may be the result of similar needs for strengthening the flight structure.

In the primitive forms there are more costal crossveins, and more branches to the radial sector than in more specialized forms, but the result is not constant, but highly variable. One point is of interest, the origin of the radial sector is usually a little beyond the end of the first anal vein, if one moves further out so does the other, *Perlinella* having both points further out than in *Perlesta.* However in *Perla immarginata,* in *Perlinella,* sometimes in *Acroneuria* the radial sector arises before end of anal vein, and in *Hydroperla* and *Calliperla luctuosa* often opposite. The position of the cord, is usually at beginning of outer third, of wing; in *Perlesta, Calliperla,* some *Acroneuria* it is before end of second third, while in *Perlinella,* and in some *Clioperla* it is beyond end of second third.

In the more primitive genera the subcosta extends out to the cord or near it, and in a few, *Acroneuria, Perlodes, Perla,* it may extend beyond the cord. In *Isogenus, Calliperla, Harrisiola, Peltoperla, Atoperla,* and *Kathroperla* it reaches the cord, or nearly so. In *Alloperla, Paraperla, Isoperla* the subcosta ends well before the cord. Sometimes it may fade out or be very indistinct as in *Nanoperla* and *Perlesta* (some species).

The number of veins in the anal area of the hind wings

is normally five, *Paraperla* has but four, *Alloperla* three, and *Hastaperla* has no anal area. In most genera the second and fifth are branched, in some *Acroneuria* and *Perla* with several branches.

In the hind wings the number of cubital cross-veins, if more than one, has been used, it varies, but is somewhat useful. The number of branches of the second and last anal veins, is also helpful, but rarely dependable. The length of the union of radial sector and medius has also been used, but too variable for a generic character.

Palpi.

The palpi in *Pteronarcys, Perla, Acroneuria* are short and inconspicuous, the last joint of the maxillary palpi very small, the third somewhat swollen at tip; in *Isogenus,* the fourth joint is longer, and in some species (*nona, ebria,* etc.) the palpi are much longer and more slender, the fourth joint prominent and the third joint not swollen at tip, while in *Alloperla* the last joint is very short, scarcely noticeable.

Setæ.

The setæ, or tails, in the primitive forms (*Perla, Acroneuria, Peltoperla*) are short and in *Perla* and *Acroneuria* much thickened at the base and taper to the slender tip. The first few joints in *Perla* are simple annulations, not real joints; in *Acroneuria* they are usually more like a joint, plainly separated by a notch on the side; in *Peltoperla* some species are similar to *Perla,* in others more distinct. Also in *Perlodes,* and *Hydroperla* some species have short setæ, the basal joints scarcely separated. But in most Perlidæ the setæ are long, often as long as abdomen, and with many joints much longer than broad, and with long erect bristles near tip of each joint.

Results.

On considering these characters in the various genera one sees that there are two primary trends or groups of primitive Perlidæ, one the *Acroneuria* group distinguished by the oblique anal brace arising from near third anal vein, the other the *Isogenus* group with an anal brace arising from the base or near base of anal cell and ex-

tended transversely across anal area and anal lobe when present. In the specialization that occurs in both lines, there comes reduction in venation, reduction in anal lobe, and many modifications that will be of use in the particular group.

Both groups have a fringe of hair on lower edge of the femora, in *Perlodes* and *Isogenus* very fine and evenly short, in *Acroneuria* more dense and with some stiffer and longer bristles. Both groups have the basal antennal joints very short, but in each line they become longer in more recent genera. In both lines the anal brace gradually weakens and disappears. In the *Acroneuria* line there is more tendency to retain and develop the bristles; but bristles appear in some of the fairly primitive genera of the *Isogenus* line, such as *Calliperla* and *Diploperla;* but in the more specialized forms (*Isoperla*) the bristles disappear, while in the most specialized group (Chloroperlinæ) of the *Acroneuria* line the bristles are most highly developed.

With the numerous similarities, as well as the differences, of structure in the group, it appears to me that in the Plecoptera there are, as Newman in 1853 stated, but three families, Pteronarcidæ, Perlidæ, and Nemouridæ, and that under the Perlidæ are eleven subfamilies, which are tabulated below.

Two courses are open in making a key to the subfamilies. In both *Isoperla* and *Alloperla* the forking of the cubitus in fore-wings is such that the upper branch of cubitus goes out straight as a continuation of the stem, while the lower branch (cubital fork) plainly diverges from the stem and upper branch of cubitus. In all other Perlidæ the forking of cubitus is so that the upper branch diverges from the stem, plainly at least a little. But the Isoperlinæ and the Chloroperlinæ (*Alloperla*) differ in so many ways, and, as I believe, the Isoperlinæ are an offshoot of the Isogeninæ that I think it better to take out the Chloroperlinæ much before the Isoperlinæ.

Another matter permits of two solutions. Whether to put together all those forms which have femoral bristles, or to dispose of them according to the forking of the

cubitus; I have chosen the latter course. Bristles are ancestral, and the occurrence of ancestral characters in descendants is not unusual.

I had started this paper in order to do identification, especially of New England Perlidæ, and had hoped to rely chiefly on body characters, but find (as others have) that there is much in the wing, particularly the basal portion that is sufficiently constant for synoptic purposes. I do not underrate male genitalia and am pleased to find that in general my results agree with the plan made by Ricker in 1943.

Table to the Subfamilies of the Perlidæ

1. Head longer than broad, eyes situate more than twice their diameter from hind margin; in the forking of cubitus the upper branch is bent a little from the stem; the third anal vein arises from the cell; no anal lobe nor anal brace; antennæ with a few joints near base short; a carina or line connecting eyes and passing just behind hind ocelli. Kathroperlinæ

   If head is longer than broad the eyes are not more than one and one-half diameter from the hind margin 2

2. Small forms less than an inch; no anal lobe nor brace; anal area of hind wings with not more than four longitudinal veins; distinct erect bristles in a row on each side of femoral groove; occipital line absent or indistinct; antennæ rather long, not thickened at base, the joints moniliform; usually in the fore wings the third anal vein branches from the second beyond the anal cell ..... Chloroperlinæ

   Anal area of hind wings with more than four longitudinal veins; in the fore wings the third anal vein leaves the second at or before end of anal cell 3

3. But two ocelli 4

   With three ocelli 6

4. Head about twice as broad as long, partly under the overhanging pronotum, latter very broad, rounded behind, straight or slightly concave in front; legs

short; setæ very short, but basal joints distinct; costal cross-veins numerous ..... Peltoperlinæ

Head usually longer; pronotum usually a little convex in front; setæ not especially short 5

5. Ocelli hardly three diameters apart; anal brace distinct, extending obliquely back; femora with bristles among the hairs, no cross-veins between first and second anal veins ..... Neoperlinæ

Ocelli fully four diameters apart; anal brace faint or absent, usually a few cross-veins between first and second anal veins ..... *Atoperla* in Perlestinæ

6. In fore-wings there is an obliquely recurrent anal brace, often arising near base of third anal vein. Third antennal joint not or little longer than the fourth joint; cubito-anal cross-vein usually at or before end of anal cell; lower edge of femora with fine hairs and some longer bristles 7

In fore wings the anal brace, if present, arises from nearer the base of the anal cell, and extends transversely across anal area and anal lobe (if present); often anal brace faint or absent. Third antennal joint much longer than broad, and sometimes narrowed in middle; cubito-anal cross-vein frequently beyond end of anal cell, and first anal vein may be bent at that point. The lower edge of femora has a row of fine, usually short hairs, but sometimes with longer bristles present 9

7. Setæ fairly long, not noticeably thick near base, the joints soon as long as broad, the fourth not several times as broad as long, often with long erect bristles at tip of joints; wings with few, if any, cross-veins beyond the cord; sometimes a few cross-veins in anal area; in male the genitalia are not visible from above ..... Perlestinæ

Setæ fairly short, thickened at base, the first few joints usually three or four times as broad as long, and not notched at base; usually a number of joints of antennæ toward base much broader than long 8

8. Radial sector beyond cord usually forks three times,

and the forks slope behind the sector, so sector fairly parallel to radius; usually some cross-veins beyond the cord; last joint of maxillary palpi usually one-half of fourth joint. In male no process or extension of fifth dorsal segment, but on ninth ventral segment is a raised median disc; subcosta often ends beyond cord ..... Acroneurinæ

Radial sector usually with but two forks and the first parts into an anterior as well as posterior branch; no series of cross-veins beyond cord, subcosta often ends before or at cord; last joint of maxillary palpi usually not one-half of fourth joint. In male the fifth segment is usually extended, and the genital prongs wholly visible from above, no median disc on the ninth ventral segment Perlinæ

9. Both wings with cross-veins beyond the cord forming several irregular cells; the portion of fore wing beyond cord rarely a third of wing-length; the cubito-anal cross-vein is well beyond the end of anal cell; ocellar triangle usually as long as broad; anal lobe distinct and quite long ..... Perlodinæ

Wings rarely with cross-veins beyond the cord, and not forming several cells; portion of fore wing beyond cord usually fully one-third of wing-length 10

10. In the forking of the cubitus in the fore wing the upper branch bends a little upward at the forking, while the lower branch also bends down a little, rarely in a curve or else does not bend at all. Radial sector often forks two or more times. Often with more than one cubital cross-vein in hind wings; cubito-anal vein sometimes broken 11

In the forking of the cubitus, it is the upper branch which continues the straight course, and the lower one diverges usually in a curve. Radial sector rarely forks more than once, and usually but one cubital cross-vein in the hind wings. The fourth joint of antennæ is usually as long as broad, and the sense-hairs distinct; median groove rarely present; cubito-anal vein normally not broken.

Isoperlinæ

11. Femora with bristles below among the shorter hairs; anal lobe very small ..... Calliperlinæ
Femora with only the fringe of short hairs below. Isogeninæ

Review of Subfamilies and Genera

Subfamily Perlodinæ

Hanson has arranged the species of this subfamily on sternal structure, and, I believe, is continuing his work, so I have not utilized sternal structure in this paper, although I have previously (1938) based a genus, *Hesperoperla,* on such characters, and in fact have called attention to the value of ventral structure many years ago (1900).

The only point I would make is that I think his *Dictyoperygella washingtoniana* belongs to the Isogeninæ, close to or the same as *Hydroperla;* and add a new genus, differing from *Perlodes* in the presence of bristles on the femora.

Perliphanes gen. nov.

Type: *Dictyogenus* (?) *phaleratus* Smith.

Head plainly broader than long; ocellar triangle a little broader than long, hind ocelli rather small, looking laterally, nearer to each other than to eyes; median groove reaching occipital line; palpi rather short, third joint thick, longer than fourth, last joint one-half of fourth; pronotum twice as broad as long, sides parallel, as also front and rear sides; setæ short, several joints beyond first broader than long. Wings with some cross-veins connecting branches of radial sector, thus forming cells much like *Perlodes.* Upper branch of cubitus bends at the forking; cubito-anal vein at end of anal cell, first anal vein not here angled; anal lobe does not reach lower end of anal cell; a transverse brace across anal area from near base of anal cell. The femora have bristles among the shorter hairs.

Subfamily Calliperlinæ

Cubito-anal vein at or near end of anal cell; the first

anal vein not angled or scarcely so near base; femora have distinct bristles among the shorter hairs.

1. Pronotum in front fully twice as broad as long; head extending back of eyes for the length of an eye; ocellar triangle twice as broad as long; last joint of maxillary palpi very short; radial sector forked twice ..... *Calliperla*

   Pronotum not so broad, head not extended so far back, ocellar triangle rarely twice as broad as long 2

2. Maxillary palpi long and slender, the joints not broadened at tip; radial sector usually forks twice. *Diploperla*

   Maxillary palpi shorter, one or two joints plainly thickened near tip; radial sector often forked but once ..... *Occiperla*

Calliperla gen. nov.

Type: *Perla luctuosa* Bks.

The ocellar triangle is twice as broad as long; hind ocelli nearer to eyes than to each other, head curving back of eyes more than length of eye. Ocellar line angulate behind, the median groove very short. Palpi very long and slender. Femora with distinct longer bristles besides the short fringe. Pronotum more than twice as broad as long. In fore wing the subcosta ends at or near cord, radial sector usually forks twice, cubito-anal cross-vein at end of anal cell, first anal vein not angled; in hind wing several cubital cross-veins. From base of anal cell in fore wings there is short, transverse anal brace, but no anal lobe; antennæ with several joints beyond the third much broader than long, with only minute erect hairs.

Diploperla Frison

This genus is based on *D.* (*Perla*) *bilobata* N. & C. This is a rather slender species in which the male shows a lobe on two ventral segments (*D. duplicata* is similar). The other forms are rather more robust, and the male has but one ventral lobe. But for the present I will keep them together; they are *modesta, verticalis, nona, tincta, sorpta* and probably *misnoma, alameda, æstivalis,* and *fulva.*

Occiperla gen. nov.

Type: *Isoperla pinta* Frison.

Head broad, behind eyes it at once slopes inward; median groove well developed; ocelli small, lateral boss about as far from hind ocellus as from base of antenna; femora with bristles among the shorter hairs; maxillary palpi moderately short, second and third joints rather thick, fifth long and slender; antennæ with moderately long joints, short hair, and minute sense hair near end of joint; pronotum much broader than long; cubito-anal cross-vein at end of anal cell; cubitus forks so both branches are at an angle with the base; anal brace arising a little before base of anal cell, transverse, no distinct anal lobe.

I have *Occiperla pinta* from Huntington, B. Col., and Cowichan Lake, Vancouver; there are at least two other species in the West, both with the area in front of anterior ocellus wholly yellowish, one with a pale longitudinal streak in the ocellar area, the other with ocellar area covered by a triangular dark spot.

Subfamily Isogeninæ

1. The anal lobe fairly large and long, ending beyond the lower end of anal cell; in hind wings a series of cubital cross-veins; moderately large specimens..... 2
   The anal lobe very small or absent, and if present it ends before the lower end of anal cell; usually smaller species 3
2. Ocellar area about as broad as long, or nearly so; head extending some distance behind eyes and plainly a little swollen before sloping inward; median groove nearly or quite reaching occipital line .....*Isogenus*
   Ocellar area but little if any broader than long; head very short behind eyes, scarcely space for more than the inward slope; median groove not reaching the occipital line .....*Hydroperla*
3. Hind ocelli far from hind border of head, not under a ridge, nor a shallow groove reaching laterally, but projecting a bit above surface, anterior ocellus almost as near each eye as to anterior margin of

head; fourth antennal joint fully as long as broad. *Megahelus*

Hind ocelli not so far from hind border of head and looking out over a broad shallow groove toward eye or antennæ; anterior ocellus much farther from either eye than from anterior border of head 4

4. Ocellar area about twice as broad as long; median groove complete and distinct; wings moderately broad ..... *Pictetia*

Ocellar area plainly not twice as broad as long; median groove sometimes complete, often not, wings not so broad ..... *Clioperla*

Clioperla N. & C.

This genus, proposed by Needham and Claassen, is based on the *Isogenus clio* Newman. Through the kindness of Mr. Kimmins of the British Museum I have learned of the generic characters which places the genus in the above table. The type is from Georgia, N. & C. identified specimens from North Carolina and Indiana. I have not been able to see these specimens; Frison saw them and said[3] that the specimens from Raleigh, N. C., are the same as his *confusa*. Specimens sent, as paratypes of *confusa*, by Frison to the M.C.Z. are very different from *clio*. In the M.C.Z. are two specimens from Woodworth Lake, Fulton Co., N. Y., which agree with color description I made of the type in 1912. The species is very close, perhaps the same, as that later described by Pictet as *Perla maculata*. Specimens that I have identified as *maculata* are from North Carolina and the White Mts., N. H.; these are smaller than *clio* and the tip of abdomen yellow, and the subgenital plate less strongly rounded.

Pictetia gen. nov.

Type: *Perla expansa* Bks.

The anal lobe is very small and short, the brace scarcely distinct; cubito-anal vein beyond tip of anal cell; palpi long and slender; back of eyes the head slopes inward.

[3] Bull. Ill. Nat. Hist. Survey 22: 331. 1942.

Isogenus Newm.

This remains as used in Needham & Claassen.

Hydroperla Frison

This includes besides the species mentioned by Frison, *varians, subvarians, hastata, guerini.*

Megahelus Klap.

This is based on *Isoperla bellona* Bks.; it has much resemblance to typical Isoperla, but the cubitus forks as in *Isogenus.* There are apparently one or two more species.

Subfamily Isoperlinæ

1. Hind ocelli almost twice as near eyes as to each other, ocellar triangle fully twice as broad as long; pronotum plainly more than twice as broad as long; spines under tibiæ stout and long; small black species ..... *Nanoperla*

   Hind ocelli not so near to eyes, and ocellar triangle not so broad 2

2. Femora with distinct longer bristles among the shorter hair; cubito-anal cross-vein at end of the anal cell ..... *Perliola*

   Femora with only the fringe of short, even hairs 3

3. Hind ocelli looking laterally out over a broad, shallow groove toward eye or antenna; inner edge of ocelli scarcely above the middle surface; mostly more or less marked with brown; sometimes with extra cubital cross-veins in hind wing ..... *Walshiola*

   Hind ocelli looking more upward, inner edge usually a little above surface between ocelli; no shallow groove, at most a small, subtriangular pit just outside of ocellus; mostly pale species; rarely with extra cross-veins in cubital area of hind wings. *Isoperla*

Isoperla Bks.

This I reduce to the forms similar to the genotype (*bilineata*) in having the cubitus forked so that the upper branch is continuous and the lower branch arising from

it at an angle or a curve; and further as in the above table. This is closely similar to the condition in *Alloperla.*

Nanoperla gen. nov.

Type: *Chloroperla minuta* Bks.

This was placed in *Isoperla* by Needham and Claassen and by Frison. It differs from *Isoperla* by the more widely separated posterior ocelli, fully twice as far apart as each from eye; by the lack of an angle at anterior corners of the pronotum; in the hind wing the median cell is fully twice as long as its pedicel; the legs and setæ are shorter; the medius of fore wing is often stopped by the first median cross-vein, and does not extend basally close to the radius as is common in Perlidæ, this is similar to *Hastaperla* and *Chloroperla;* in the anal area the third anal vein usually branches from the second at the end of anal cell, sometimes a little beyond, rarely before it. Its dark fore wings with the costal area yellowish also separates it from Isoperla. In both sexes the genitalia are different from the normal Isoperla.

Nanoperla minuta occurs in the mid-western States, Ohio, Michigan, Illinois. It may be, as Frison suggests, that it is the *Chloroperla nana* Walsh. His description is short, and the size is a little large for a dried specimen; his unique type was from Rock Island, Illinois; Frison says that *minuta* occurs in the central and eastern part of Illinois.

Walshiola gen. nov.

Type: *Perlinella signata* Bks.

In Isoperlinæ, the upper branch of cubitus continues the line of the base; cubito-anal at tip of anal cell or a little beyond; radial sector forked once or twice; the head back of eyes at once curves inward; median groove usually reaches the occipital line, which, beyond each ocellus fades; hind ocelli looking out laterally over a broad, shallow groove; ocellar triangle a little broader than long; a rather wide space between arms of the V-mark; fourth antennal joint about or fully as long as broad; palpi long and slender, fourth joint rather longer than third.

Contains also *montana* Bks. and *marlynia* N. & C.

Perliola gen. nov.

Type: *Isoperla 5-punctata* Bks.

In this the cubitus forks as in typical *Isoperla,* but the femora are usually thicker (front pair) and with more numerous hairs and among them longer bristles; the ocelli are small, the lateral boss about as large and almost as far from hind ocellus as from the base of antenna; median groove present and usually visible. The maxillary palpi are short, the second and third joints at least rather thick; the joints of antennæ though much longer than broad are not as long as in *Isoperla,* and the hair is usually shorter. There are several species in the Western States, one with much resemblance in subgenital plate to *Isoperla sobria* Hag.

Subfamily Perlestinæ

The three genera in our fauna are separable as follows.

1. A series of costal cross-veins (five to ten or more) before end of subcosta; head broader behind than long; no cross-veins connecting anal veins beyond cell; three ocelli; first anal ends before origin of radial sector ..... *Perlesta*

   First anal vein usually ends about as far out as origin of radial sector; rarely more than one or two costal cross-veins before end of subcosta; head sometimes as long as broad; often one or more cross-veins in anal field 2

2. With but two distinct ocelli; rarely with more than one or two cross-veins between first and second anal veins; front femora about equal to width of pronotum ..... *Atoperla*

   With three ocelli; usually three or more cross-veins connecting first and second anals; front femora not as long as width of pronotum ..... *Perlinella*

Subfamily Neoperlinæ

There is but one genus, *Neoperla,* in the U. S., others with many species occur in tropical areas and in East Asia.

Subfamily Acroneurinæ

The numerous species of this subfamily are placed in *Acroneuria, Claassenia, Eccoptura, Beloneuria,* and *Hesperoperla.*

Subfamily Perlinæ

The few genera, *Perla, Togoperla, Banksiana, Harrisiola,* have been separated by Klapalek and others; it is necessary to distinguish the female of *Harrisiola* from *Perla* (*Togoperla*). In *Harrisiola* (both sexes) the occipital line ends on the outer end of the lateral boss, in *Perla* the line does not bend forward so far, but runs toward the eye, well behind the boss. *Perla* has a tiny last joint to maxillary palpi.

Subfamily Kathroperlinæ

We have in America but the typical genus which occurs in British Colombia and adjacent areas. There are other genera in Formosa and China.

Subfamily Chloroperlinæ

The four genera, *Paraperla, Alloperla, Chloroperla,* and *Hastaperla,* were tabulated by Frison in 1942.

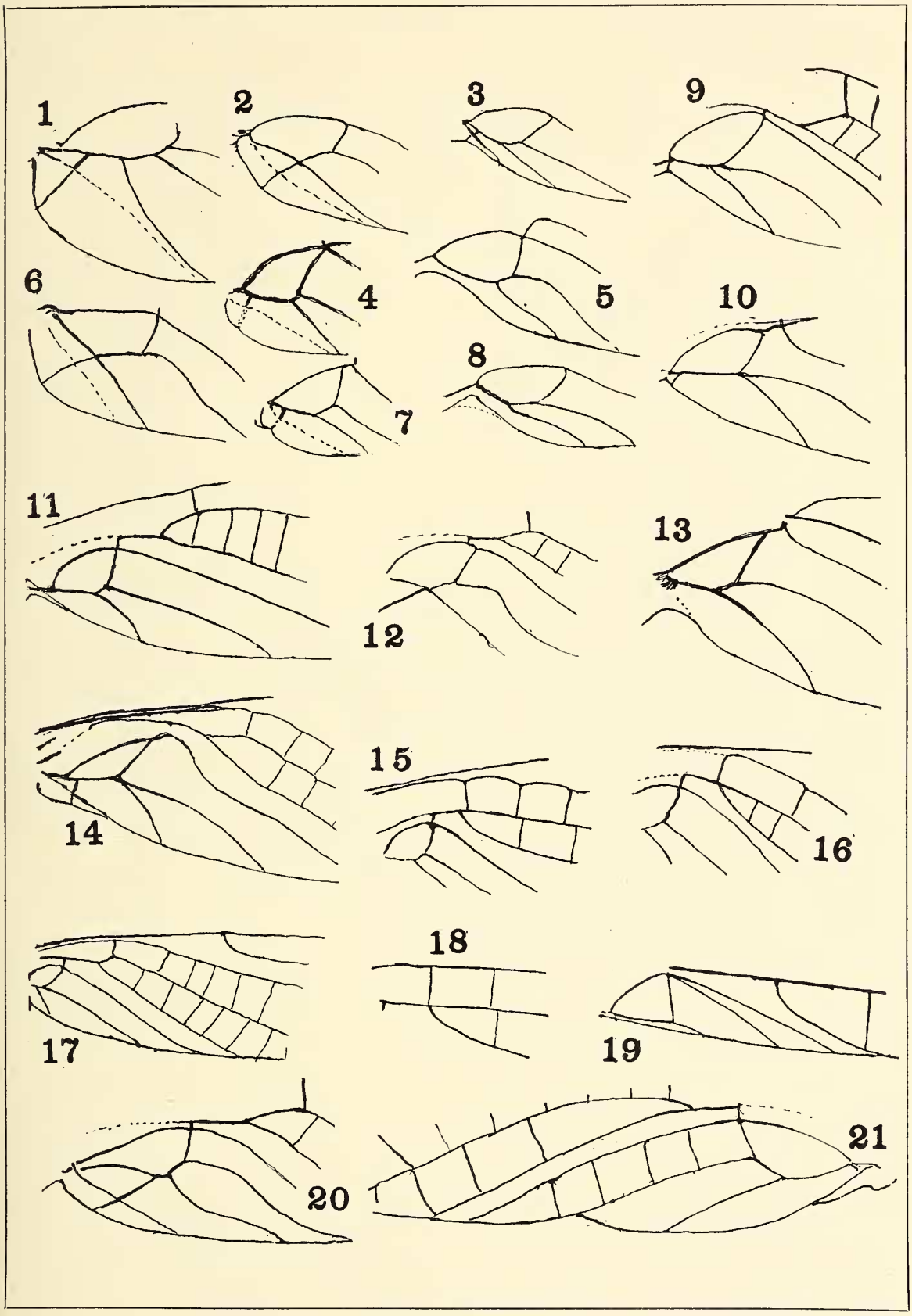
Subfamily Peltoperlinæ

So far all the forms have been kept in the one genus *Peltoperla,* but *P. cora* will doubtless become at least a subgenus.

Explanation of Plate 20

Fig. 1. *Pteronarcys spinosa*, anal part of fore wing.
Fig. 2. *Harrisiola flavescens*, anal part of fore wing.
Fig. 3. *Clioperla ebria*, anal part of fore wing.
Fig. 4. *Perlodes signata*, anal part of fore wing.
Fig. 5. *Peltoperla maria*, anal part of fore wing.
Fig. 6. *Acroneuria lycorias*, anal part of fore wing.
Fig. 7. *Isogenus frontalis*, anal part of fore wing.
Fig. 8. *Walshiola montana*, anal part of fore wing.
Fig. 9. *Kathroperla perdita*, anal part of fore wing.
Fig. 10. *Diploperla*, anal part of fore wing.
Fig. 11. *Clioperla similis*, basal part of fore wing.
Fig. 12. *Banksiana kansensis*, anal part of fore wing.
Fig. 13. *Pictetia expansa*, anal part of fore wing.
Fig. 14. *Hydroperla subvarians*, basal part of fore wing.
Fig. 15. *Isoperla bilineata*, anal part of fore wing.
Fig. 16. *Isoperla transmarina*, anal part of fore wing.
Fig. 17. *Diploperla bilobata*, basal part of fore wing.
Fig. 18. *Perliola 5-punctata*, forking of cubitus.
Fig. 19. *Hastaperla brevis*, anal part of fore wing.
Fig. 20. *Togoperla immarginata*, basal part of fore wing.
Fig. 21. *Atoperla fumipennis*, basal part of fore wing.

PSYCHE, 1947 VOL. 54, PLATE 20

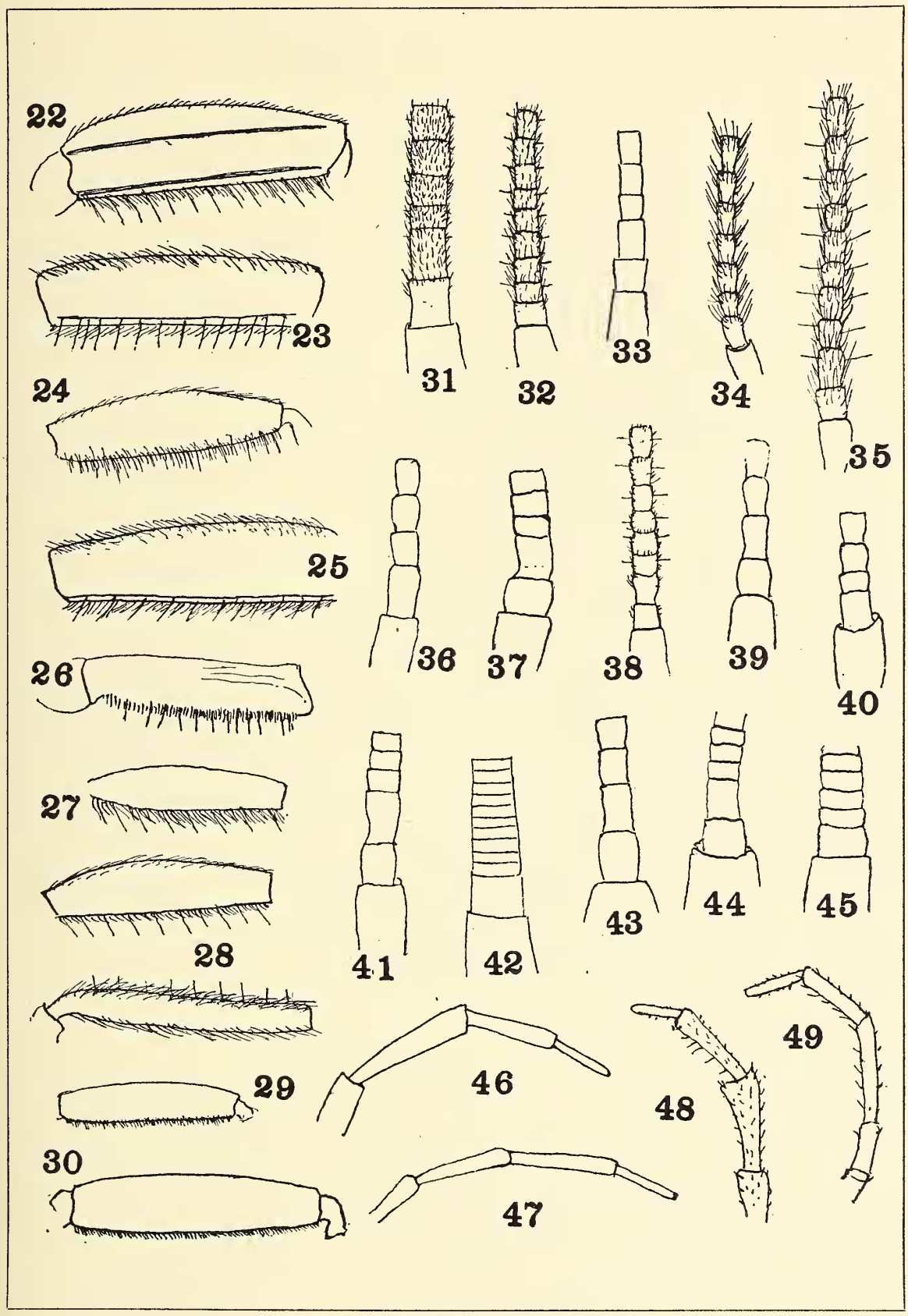


BANKS—PERLIDÆ

Explanation of Plate 21

Fig. 22. *Perliphanes,* femur.
Fig. 23. *Calliperla,* femur.
Fig. 24. *Diploperla bilobata,* femur.
Fig. 25. *Togoperla immarginata,* femur.
Fig. 26. *Occiperla* sp., femur.
Fig. 27. *Hastaperla brevis,* femur.
Fig. 28. *Alloperla imbecilla,* femur and tibia.
Fig. 29. *Isoperla,* femur.
Fig. 30. *Hydroperla,* femur.
Fig. 31. *Isogenus,* basal portion of antenna.
Fig. 32. *Perlesta,* basal portion of antenna.
Fig. 33. *Isoperla bilineata,* basal part of antenna.
Fig. 34. *Hastaperla,* basal part of antenna.
Fig. 35. *Alloperla,* basal part of antenna.
Fig. 36. *Isoperla? mohri?,* basal part of antenna.
Fig. 37. *Diploperla modesta,* basal part of antenna.
Fig. 38. *Walshiola montana,* basal part of antenna.
Fig. 39. *Megahelus bellona,* basal part of antenna.
Fig. 40. *Neoperla clymene,* basal part of antenna.
Fig. 41. *Perlodes signata,* basal part of antenna.
Fig. 42. *Acroneuria,* basal part of antenna.
Fig. 43. *Clioperla maculata,* basal part of antenna.
Fig. 44. *Calliperla luctuosa,* basal part of antenna.
Fig. 45. *Perla* and *Togoperla,* basal part of antenna.
Fig. 46. *Isogenus frontalis,* maxillary palpus.
Fig. 47. *Diploperla bilobata,* maxillary palpus.
Fig. 48. *Perliola 5-punctata,* maxillary palpus.
Fig. 49. *Clioperla ebria,* maxillary palpus.

PSYCHE, 1947 VOL. 54, PLATE 21

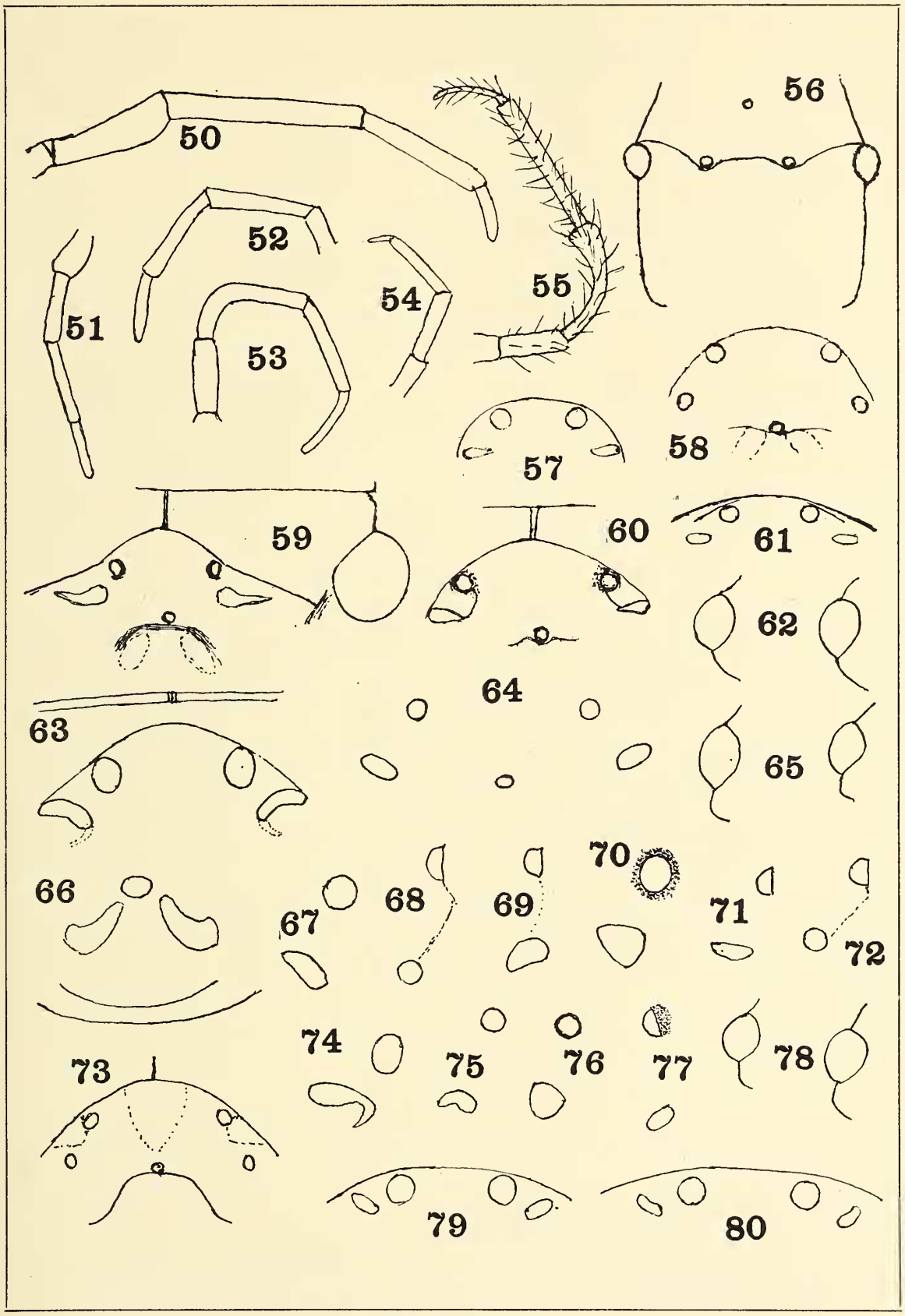


BANKS—PERLIDÆ

Explanation of Plate 22

Fig. 50. *Togoperla immarginata*, maxillary palpus.
Fig. 51. *Peltoperla maria*, maxillary palpus.
Fig. 52. *Isoperla bilineata*, maxillary palpus.
Fig. 53. *Harrisiola flavescens*, maxillary palpus.
Fig. 54. *Alloperla coloradensis*, maxillary palpus.
Fig. 55. *Perlesta*, maxillary palpus.
Fig. 56. *Kathroperla*, head.
Fig. 57. *Harrisiola*, ocellar area.
Fig. 58. *Perliola 5-punctata*, ocellar area.
Fig. 59. *Hydroperla hastata*, ocellar area.
Fig. 60. *Isogenus frontalis*, ocellar area.
Fig. 61. *Perla capitata*, ocellar area.
Fig. 62. *Walshiola marlynia*, (left) *Diploperla modesta*, (right) eye and side of head.
Fig. 63. *Togoperla immarginata*, ocellar area.
Fig. 64. *Calliperla luctuosa*, ocellar area.
Fig. 65. *Perlodes* (left), *Isogenus* (right), eye and side of head.
Fig. 66. *Togoperla immarginata*, lower face.
Fig. 67. *Acroneuria californica*, ocellus and boss.
Fig. 68. *Diploperla misnoma?*, ocellus and boss.
Fig. 69. *Atoperla ephyre*, ocellus and boss.
Fig. 70. *Neoperla clymene*, ocellus and boss.
Fig. 71. *Megahelus bellona*, ocellus and boss.
Fig. 72. *Clioperla maculata*, ocellus and boss.
Fig. 73. *Walshiola signata*, ocellar area.
Fig. 74. *Togoperla immarginata*, ocellus and boss.
Fig. 75. *Walshiola montana*, ocellus and boss.
Fig. 76. *Peltoperla arcuata*, ocellus and boss.
Fig. 77. *Alloperla borealis*, ocellus and boss.
Fig. 78. *Clioperla ebria* (left), *Perlinella drymo* (right), eye and side of head.
Fig. 79. *Eccoptura xanthenes*, ocellar area.
Fig. 80. *Acroneuria carolinensis*, ocellar area.

PSYCHE, 1947 VOL. 54, PLATE 22



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